

**U.S. ARMY BAYLOR GRADUATE PROGRAM IN
HEALTH CARE ADMINISTRATION**

**THE PRIMARY CARE COMPUTER SIMULATION:
OPTIMAL PRIMARY CARE MANAGER EMPANELMENT**

**A GRADUATE MANAGEMENT PROJECT SUBMITTED TO
THE FACULTY OF BAYLOR UNIVERSITY
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MASTERS OF HEALTH CARE ADMINISTRATION**

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ABSTRACT

Commanders of Military Treatment Facilities (MTFs) throughout the Military Health Services System (MHSS) face a common dilemma as TRICARE Managed Care Support (MCS) Contracts are implemented: How many beneficiaries should the Facility empanel per Primary Care Manager (PCM)? Leaders at Evans Army Community Hospital at Fort Carson, Colorado decided to study this problem using MedModel_{tm} Computer Simulation Modeling Software due to its quality graphical animation capabilities and its ability to simulate the hundreds of simultaneously-occurring events of a primary care setting.

Several incentives exist for Commanders to enroll the maximum number of eligible beneficiaries in MTF Prime. Most significantly, the Department of Defense will allocate future budget authorizations based on a capitated methodology tied to enrollment. Hospitals face several incentives to avoid over-enrollment to include failure to meet Congressionally mandated access standards and patient dissatisfaction. Dissatisfied patients, and reimbursement for their care, will migrate to MCS Contractors. On the other hand, under-enrollment could also be devastating to the MTF. DoD funding will follow the flow of patients away from the MTF and to the contractor through the Bid-Price-Adjustment process.

In order to answer the primary research question of how many patients to empanel, three secondary research questions were addressed. First, what was the demand for care in the MTF? This was found using the Defense Management Information System and the Ambulatory Data System (ADS). Second, how many visits per year did each beneficiary require? This was determined by collecting data from ADS and by surveying medical records. Third, what was the expected supply of health care (patient throughput) in each clinic for the upcoming year? This was estimated using Computer Simulation. Three models were built: the Family Practice Clinic, the Internal Medicine Clinic, and the Pediatric Clinic. Each model simulated a month of operation and was run 12 times in order to simulate the first year of TRICARE.

Data was collected on several variables and input into the Primary Care Simulation in order to construct a valid model. These variables included: patient time at reception desks, para-provider/patient interaction in screening rooms, provider/patient interaction time in exam rooms, provider time and frequency on the phone, and provider time spent on all extra activities which prevent scheduled appointments for MHSS providers such as Medical Officer of the Day (MOD), MOD recovery, deployments and other temporary duty, leave, training, committees, Troop Medical Clinic duty, administrative time, and daily and monthly staff meetings.

The results provided the MTF leadership with a starting point for enrolling beneficiaries in TRICARE Prime. It also provided a simulation model to perform "what if" analysis for future management decisions affecting Primary Care. Most notable is the potential for the Primary Care Simulation to increase throughput and thus budget allocations for MTFs under **Enrollment Based Capitation (EBC)**.

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INTRODUCTION

Conditions which prompted the study

TRICARE is a Department of Defense initiative which incorporates the benefits of managed care into a new health care plan for Military Health Services System (MHSS) beneficiaries. The program combines features of Military Treatment Facility (MTF) care with the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) care in order to provide more efficient utilization of resources. The organizational structure of TRICARE includes 12 Health Services Regions across the country controlled by Lead Agents. Lead Agents maintain oversight over Managed Care Support (MCS) Contracts between the Federal Government and regional contractors, charged with care for DoD beneficiaries that would have formally been covered under CHAMPUS.

In Lead Agency Region 8, which includes the states of Colorado, Kansas, Iowa, North Dakota, South Dakota, Montana, Wyoming, Idaho, Missouri, Utah, Nebraska, and Minnesota, the TRICARE Managed Care Support Contract between the Government and TRIWest Incorporated will take effect on April 1, 1997. TRICARE Service Centers will start the process of enrolling MHSS beneficiaries in the health maintenance organization (HMO) health insurance option known as "Prime" in a 30 to 60 day window prior to the start of the contract. Under TRICARE, beneficiaries may choose from three coverage options - Prime, Extra and Standard. If Prime is chosen, one must also choose between enrollment with a primary care manager at the MTF or with the contractor. A primary

care manager (PCM) coordinates all one's healthcare needs. Under the PCM concept, enrolled members are assigned to a identified individual or group/team of primary care providers for comprehensive primary health care.

Questions abound within the Evans Army Community Hospital (EACH), Fort Carson, Colorado, as to how many beneficiaries can actually enroll in TRICARE Prime while meeting TRICARE Department of Defense directed access standards. The number of active duty dependent (ADD) beneficiaries in the EACH TRICARE Service Area is 32,250 while the number of non-active duty dependents (NADDs) under age 65 is 22,905 according to Defense Medical Information System (DMIS) data. The active duty population of Ft Carson is 18,052. The access standards, according to the TRICARE Request for Proposal (RFP), are four weeks for a wellness visit, one week for routine visits, and one day for acute illness. These are also the universally accepted standards of the National Committee on Quality Assurance. Prior to enrollment, the MTF Commander must know how many personnel may be empaneled per MTF PCM and how many personnel are expected to be enrolled into the contractor's network. Under TRICARE, EACH will enroll beneficiaries in one of three primary care areas: Family Practice, Internal Medicine, and Pediatrics.

There are several incentives for enrolling the maximum number of eligibles. The MTF budget is tied to enrollment; user surveys conducted by Office of the Assistant Secretary of Defense for Health Affairs (ASD-HA) will determine how many beneficiaries are receiving care at the MTF versus downtown. Health Affairs will allocate annual budgets using a capitated methodology (per user per year).

Hospitals face several incentives to avoid over-enrollment. If over-enrollment occurs, MTFs will find it difficult to meet the Department of Defense's (DoD) contractually-obligated access standards, and thus, patient dissatisfaction will rise. Historically, access has been a dissatisfier to our beneficiaries. DoD claims to fix this problem by promising the TRICARE access standards. If customer dissatisfaction continues, the MHSS beneficiaries will chose a PCM within the TRIWest civilian network. A large migration away from the MTF PCMs toward the TRIWest PCMs might ensue at the conclusion of the beneficiaries' one-year required enrollment. As patients flow away from the MTF and to the contractor, so will dollars flow in the same direction. Another course of action is for the MTF to hire additional staff to accommodate the increased patient load. This would be difficult because funding would come from an already shrinking Operations and Maintenance budget (Jordan 1996).

Another problem with over-enrollment is that it prevents the PCMs from actually "managing" the care of their patients through good utilization management. If staffing ratios are too lean in terms of providers per members, stress levels of the PCMs will rise as they attempt to take care of the needs of their panel. PCMs will have less time and patience for evaluating problems and will refer an increasing number of patients to specialists for all but the most routine of cases. In addition, a PCM's negative attitude can be reflected back to the beneficiary (Kongstvedt 1995).

On the other hand, under-enrollment could also be devastating to the MTF. DoD funding will follow the flow of patients away from the MTF and to the contractor. This "bid-price-adjustment" occurs after the first year of the TRICARE Managed Care Support contract and compensates TRIWest for beneficiary utilization over and above the services

it originally bid (Montgomery 1997). By losing primary care patient episodes, the hospital would also stand to lose its present referral base for outpatient and inpatient specialty care.

Several other disadvantages exist to under-enrollment. Professional and support staffs would not be fully utilized. Additionally, fewer patients might prevent providers from sustaining certain clinical skills. Also, it will take a much greater effort to bring back TRIWest Prime enrollees, especially if they are satisfied, into the MTF system (Jordan 1996). One final disadvantage is the impact of the newly-implemented "Utilization Management Decrement" in which ASD-HA takes money from MTFs for their lack of operational efficiency.

Health care organizations in general with a lower number of enrollees-per-provider, may develop an unsupportable overhead cost. Overstaffing, over a period of time, results in productivity inefficiencies. When low productivity levels become normal efforts to improve processes are met with resistance because providers are then expected to work harder for no additional compensation. When this occurs, physicians defend the status quo by stating management's demands for increased efficiency "will have a negative impact on patient care quality" (Kongstvedt 1995).

Statement of the Problem

The immediate problem is that the Command has made estimates of how many beneficiaries may be enrolled which are not backed up with detailed analysis. Because the forecasts made thus far of empanelment numbers for 1997 have been based on many large assumptions, the Command is not highly confident in these findings.

Literature Review

A review of the literature revealed three basic methods for determining PCM empanelment ratios. The first method is derived through benchmarking in which the ratio of PCMs to patients within health care organizations is averaged to achieve a base line. The second method is the static mathematical model in which spreadsheets are used to develop a formula comprising several variables which are assigned a mean value. During the course of this literature search, a third method, computer simulation, was researched to determine if it was a viable alternative. One study produced empanelment recommendations from simulation. In computer simulation, a model of a process is developed, and a series of trial-and-error experiments are conducted in order to make assumptions about event outcomes over time (Leven et al 1992).

Benchmarking.

Kongstvedt discusses benchmark staffing ratios in terms of closed health plans, that is, group and staff model panel HMOs or large group practices with a high proportion of managed care business. Averages are provided to help organizations establish ratios, but he points out that numbers vary depending on the size of the health plan, the geographical location, and the proportion of Medicare enrollees. A large, mature closed panel plan, serving a predominately commercial population enrolls a mean members-per-physician value of 1250 patients per primary care provider (PCP). Larger plans tend to have a greater number of patients per PCP due to the ability to achieve economies of scale (Kongstvedt 1995).

The U.S. Army Medical Command (MEDCOM) Manpower Division conducted a study which used benchmarking to establish staffing levels. The analysis subtracted time from staffs' assigned hours for continuing education, standard non-available hours, readiness training, and ward rounds to yield "available hours." Using a regression analysis, man-hours of a MTF's clinic were plotted on the Y axis, while total visits for the MTF clinic were plotted on the X axis. The result yielded a regression equation which served as a benchmark for all MTFs in the system (MEDCOM 1995).

The MEDCOM benchmark study established an optimum staffing profile based on a "most effective group" technique. The most effective groups were those MTFs that yielded the most efficient staffing mix and were one standard deviation below the mean for a particular medical specialty. The benchmark was defined by the average amount of time providers use per visit in the "most effective group" of MTFs category. The next step was to determine the staffing profile for each clinical area based on the ratio of providers, nurses, para-providers, and administrative personnel used at the "most effective group" locations (Harper 1995).

Another method for determining empanelment numbers, used by most HMOs employees a combination of benchmark data and actuarial data. The ratio of 2000 per provider is uniformly used for family practice physicians using two exam-rooms each. Likewise, the enrollment numbers of 1400 and 1200 are used for pediatricians and internists, respectively. However, "equivalency factors" which account for individuals' age, sex, and chronic illness are assigned to each enrollee. Thus, one patient might count as 1.3 patients so that a family practice panel with a relatively high number of patients with chronic illness would consist of fewer than the standard 2000 members (Anderson 1996).

Static Mathematical Models

Several spreadsheet models have been developed to determine enrollment ratios. TRICARE Region Eight Lead Agency developed a spreadsheet which arrives at an enrollment capacity for MTFs. Appointments per day for Family Practice, Internal Medicine, and Pediatrics are given an assumed value (25, 18, and 25 respectively). This figure is multiplied by the days the provider is assumed to be available for duty (4.7, 4.7, and 4 respectively). The resulting product is multiplied by the weeks it is assumed the provider is available per year (41 for all providers). This figure is then divided by the assumed visits per patient per year (3.4 for all cases). The result is the number of enrollees per provider (Region 8 Lead Agency 1996).

The Managed Care Office at EACH derived different estimates after examining past workload. This analysis estimated less enrollment capacity than the Lead Agency spreadsheet. An additional study was conducted by Chief of Family Practice Peter Torok at EACH which accounted for clinic absences and reduced the number of days a provider is available from 4 weeks to 21 weeks. In this study, Torok reduced provider available days for the following reasons: leave, continuing medical education (CME), holiday schedules, temporary duty (TDY), deployments, on-call duty, administrative half days, Federal holidays, training holidays, continuous quality improvement meetings, officer professional development, and perinatology meetings. The study also indicated the number of visits per year, 3.4 from previous studies, was too low due to the frequent visits by obstetrics (OB) patients and ill children. Four is a "low estimate" he stated (Torok 1996).

The Empanelment Spreadsheet Program (ESP) was designed by James Wooten to assist MTFs in determining their enrollment capacity for PCMs. This analysis adds to the empanelment equation a factor called "patient units" which describe the acuity-level of care *required* in a beneficiary catchment area. This figure is compared against the "patient units" of care *available* in the MTF to suggest the number of active duty, active duty dependent, and retiree beneficiaries an MTF can empanel. To arrive at the required care value, population statistics by age, sex, and beneficiary category from the Defense Medical Information System database are entered. This data is factored, using an actuarial table to determine a weighted value called "patient units of care required." Additionally, the user must enter the average number of weeks a provider is available; a different value is allowed for military and civilian providers. The user also enters the average visits per year expected and the number of full time equivalent (FTE) providers on staff (Wooten 1996).

Computer Simulation

In the above examples, mathematical models are constructed to describe the operational characteristics of primary care clinics and described in terms of numerical equations. For the most part, the values assigned to variables are constants based on averages. Such linear programming models assume that the utilization of medical services occurs at a constant level. Computer simulation differs from linear models because it is event driven, that is, an event happens at a certain point in time, such as, a patient arriving at a clinic. In simulation, an event's occurrence can change the value of a variable. A large quantity of events produce occurrences which can be observed and their results averaged in order to understand how a system works (Harrell et al 1995).

An extensive literature search found only one reference on the use of simulation studies to determine appropriate enrollment numbers in primary care clinics. However, several published works show computer simulation has been widely used to predict the probable effects of health care management decisions on throughput, staffing mix, customer satisfaction, and resource consumption. Because of the obvious value of computer simulation in health care services, a review of current literature will follow. Published articles were found which center on both inpatient and outpatient services within health care facilities. This review will focus on outpatient studies to include ancillary services and emergency room systems because this study involves outpatient care.

Ledlow built a computer simulation model using the MedModel_{tm} Software for the purpose of determining the optimal provider staffing mix for the Heidelberg U.S. Army Medical Department Activity Family Practice Clinic. The model compared total patient throughput across three different options to include the Status Quo Model, the All-Physician Model, and the Combination Physician/Extender Model. The study concluded the All-Physician Model was the most efficient for the Clinic based on evaluative criterion of total patient time in clinic, relevant costs, time to implement, and provider availability (Ledlow 1996).

Uyeno applied simulation to a pediatric clinic using SIMSCRIPT_{tm} software. The model determined the most efficient health care team compositions for different demand levels and exam room configuration. Nine combinations of staff members were tested, and up to two pediatric nurse associates and two pediatric assistants were allowed on each team. Ten scenarios were modeled to include six different levels of examining, as well as

four different levels of patient workload. The study found that demand levels impact on optimal team composition. The optimal solution maximized annual return of dollars. When demand is low, allied child health staff are not needed. If demand for care increases, a pediatric assistant should be added to the team first. As demand continues to rise, a pediatric nurse associate is added. At greater demand levels, an optimal addition to the team is a pediatric assistant. In addition, it was concluded that the addition of examining rooms, after a certain point, provided minimal effects on utilization (Uyeno 1974).

In a study of an outpatient diagnostic center, Wilt described a project which used Micro SAINT_{tm} software and examined staffing requirements and facility design. A new diagnostic center was in the planning stages and was to serve as a centralized testing facility for outpatient services which included blood tests, X-rays, EKGs, CAT scans, examinations and mammograms. The proposed center was modeled, and areas with potentially long wait times were identified. Once identified, "what-if" analysis tested alternatives which eliminated bottlenecks. For example, excessive X-ray waiting times were observed, and a more appropriate staffing mix was recommended. Additionally, congestion in the waiting area was noted, and the modeler recommended converting a storage room to an internal gowned waiting room. These recommendations were accepted and implemented in the new center (Wilt and Goddin 1989).

Levy discussed a simulation model for an outpatient services center which was under construction. The model utilized historical data to analyze outpatient services utilization, patient waiting and flow times, and queue sizes. It was determined through simulation that when inter-arrival times between patients decreased, the maximum number

of patients at the registration desk increased. As patient volumes fluctuated, the number of patients in the waiting room ranged from eight to fifteen. Based on these findings, the simulators recommended staffing requirements and the size of the waiting room (Levy, Watford, and Owen 1989).

In a paper on improving patient waiting times in the United Kingdom, Paul describes the use of the CLINSIM_{tm} modeling package. The National Health Service in the UK is notorious for long wait times for primary care patients. Computer simulation was chosen to evaluate this problem after other attempts to include queuing theory and statistical analysis failed. The CLINSIM_{tm} model accounted for the fact that the clinic was overloaded with patients at the start of each day and the fact that doctors arrived at clinics in an irregular pattern, not always on time. After testing and validation among 20 test sites, the model is helping clinic leaders to develop an understanding of their systems and subsequently address problems (Paul and Kuljis 1995).

Using MedModel_{tm} simulation software, Arvey studied the effects of staffing adjustments on patient throughput times within an obstetrical and gynecological outpatient clinic. A team concept was explored in which a team consisted of two providers, two nurses, and a nurse aide. Each team had a specific exam room assigned to them. Additionally, a team consisting of one provider, one nurse, and one nurse aide was simulated. The model also examined the effects of adding two exam rooms. The study found that just adding two exam rooms without staffing adjustments had no significant effects on patient time in the clinic which averaged 106 minutes. The optimal solution, which reduced patient time to below 90 minutes, was the mix of one provider, a nurse, and a nurse aide in which each provider had two or three exam rooms available

(Arvey and Morin 1997).

With SIMAN_{tm} software, Mukherjee conducted a simulation study of a hospital pharmacy in which he accounted for the flow of regular orders, critical orders, outpatient orders and telephone calls through the system. In this study, the author sets out these four processes with flow charts which help illustrate how these entities move through the system. This article is unique in that it models the flow of telephone calls and the effects their interruptions have on the other entity flows within the system. The author also recommends the use of Chi-Square tests for goodness of fit in order to describe the various distributions of activities such as pharmacist triage time, pharmacist order validation time, inter-arrival time of critical orders, etc. The study was able to show management it could investigate various operations strategies using computer simulation (Mukherjee 1991).

In an emergency department (ED) setting, Draeger modeled a system using the GPSS/H_{tm} and PROOF_{tm} simulation and animation packages providing visual, dynamic displays of activity. Two solutions to the problem of high waiting times were evaluated: alternative nurse staffing schedules and re-routing of certain patients away from the ED. New nurse schedules were suggested which better matched the patient volume patterns. Two scenarios were evaluated, and it was determined that the best solution decreased coverage between 1am and 4am and increased coverage between 5pm and 7pm seven days a week, and increased coverage between 1pm to 5pm Monday through Thursday. The second proposal evaluated establishing a "fast lane" re-routing of non-urgent, primary care patients out of the ED, and four scenarios were evaluated. Using simulation modeling,

the optimal solution re-routed patients into the organization's primary care system between 11am and 9pm (Draeger 1992).

Another ED simulation was produced by Kertland using MedModel_{tm} software which was based upon the review of four hundred randomly-chosen medical records. The following data was extracted from the records: arrival time, patient acuity, patient type, the number and kind of ancillary tests performed, the procedures performed, the discharge disposition, the discharge times, and the mode of arrival. A ED model was then constructed using the collected data. Next, running a minimum of 20 replications, the model was validated against historical data, comparing average patient lengths of stay for 12 different patient types. After the model was validated, eleven scenarios were modeled with the goal of improving patient flow. Three alternatives produced significant savings of patient turn-around time: (1) Establishing a "fast track" care for primary care patients (2) placing patients in treatment areas when beds were available instead of routing them back to the waiting room and (3) using a point-of-care lab. The combination of these three proposed process improvements reduced patient turnaround time by 38 minutes (Kirkland et al 1995).

Finally, a ED simulation by Garcia et al also studied the implementation of a "fast track" lane. The fast lane was set up to reduce the waiting time of non-urgent patients. Studies showed this category of patient had the longest stay in the system (2-3 hours). By modeling the ED, the length of stay of this patient type was reduced by 25% without increasing the length of stay of urgent or emergent patients (Garcia et al 1995).

To summarize the literature review, three methods for calculating enrollment are presented: benchmarking, mathematical models and simulation. Simulation offers

advantages over the others in certain circumstances. In an actual Primary Care Clinic, events do not occur the same way each time. Often an atmosphere of uncertainty abounds because the human factor increases the potential for variation. A Simulation study is unique in its ability to incorporate variations into a model thereby improving the accuracy of the results. Therefore, computer simulation will serve as the analytical instrument to conduct this project.

Purpose

The purpose of this project is to determine how many beneficiaries can be empaneled per PCM. These results will be used to determine the total number of beneficiaries that the MTF may empanel. PCMs will fall into three categories for enrollment: Family Practice (FP), Internal Medicine (IM) and Pediatrics (Ped). Patient categories consist of Active Duty Service Members (AD), Dependents of Active Duty Service Members (ADD), Retired from Active Duty Service Members and their dependents, referred to in this study as Non-Active Duty Dependents (NADD) and Medicare Eligible Retired Members, referred to in this study as the Over-65 Category (>65). The second purpose of this project is to provide a model by which "what if" analysis may later determine ways of increasing clinic throughput. Enrollment Based Capitation, the future MHSS budgetary allocation methodology, incentivizes MTFs to maximize enrollment to Prime. Thus simulation of the Primary Care Clinics at EACH would help maximize revenues, an up-and-coming metric ASD (HA) will use to measure commanders' success.

METHOD AND PROCEDURES

Methodology

In order to answer the primary research question of how many patients to empanel, three secondary research questions were addressed. First, what was the demand for care in the MTF? Second, how many visits per year did each beneficiary require? Third, what was the expected supply of health care (patient throughput) in each clinic for the upcoming year? Several variables are included in the discussion on methodology, and are redefined in Appendix 1.

Demand for Enrollment

The total demand for care is equivalent to the number of beneficiaries in the MTF catchment area. For the purposes of this study, it was assumed that all beneficiaries would prefer to enroll in MTF Prime. The total number of beneficiaries per patient category was collected from the Defense Management Information System (DMIS) data base. See Table 1.

TABLE 1, Aggregate Demand for Enrollment

	<i>AD</i>	<i>ADD</i>	<i>NADD</i>	<i>>65</i>
<i>Total</i>	562	32,562	24,296	6,340

The next step was to divide the aggregate numbers between the three clinics so that leadership could understand with which PCM the beneficiaries would likely enroll. No report in the MHSS currently was able to categorize users, so a method was developed. First, data on total visits per clinic was collected for Fiscal Year 1996 from the Military Expense and Performance Reporting System (MEPRS), and the visits were divided proportionately among the categories of users by assigning relative value units (RVUs). Specifically each RVU was multiplied by the total visits column in Table 2. The RVUs were based on a survey of data from the Ambulatory Data System (ADS). The ADS is a DoD information system designed to track all ambulatory patient encounters while improving medical surveillance and statistical trending for better utilization management. This survey showed visits to the FP Clinic over the last 6 months were made in the proportion of: 0.0575 AD, 0.7604 ADD, 0.1866 NADD, and 0.0530 >65. Similar RVUs were developed for the IM and Peds Clinics from the same survey. See Table 2. Note that the number of AD FP units always stays at 562. This is the total number of AD soldiers who receive primary care at the MTF and will continue to do so. This number remained a constant throughout the analysis.

TABLE 2, Total Visits Divided Among Users

<i>Clinic</i>	<i>Total Visits</i>	<i>AD</i>	<i>ADD</i>	<i>NADD</i>	<i>>65</i>
<i>FP</i>	63,689	562	48,426	11,886	3,377
<i>IM</i>	38,812		2,136	19,963	16,713
<i>Peds</i>	12,717		10,237	2,480	
<i>Total</i>		562	60,799	34,330	20,089

Second, to be of value to the project, the numbers in Table 2, which represented visits (except the 562 ADs), were converted to individual users. This was accomplished by multiplying another RVU by the DMIS beneficiary data from Table 1. The RVUs were obtained by dividing individual patient category numbers in Table 2 by the total of category visits found at the bottom of each column in Table 2. This yielded the estimate shown in Table 3. Note totals now match the DMIS data from Table 1.

TABLE 3, Estimated Demand for Enrollment

<i>Clinic</i>	<i>Total Visits</i>	<i>AD</i>	<i>ADD</i>	<i>NADD</i>	<i>>65</i>
<i>FP</i>	63,689	562	25,935	8,412	1,066
<i>IM</i>	38,812		1,144	14,128	5,274
<i>Peds</i>	12,717		5,482	1,755	
<i>Total</i>		562	32,562	24,296	6,340

Visits Per Year

Another analysis was now required to determine the frequency of visits that each beneficiary made to the EACH Primary Care Clinics in the course of a year. The estimated frequency of visits was found for each of the four patient beneficiary categories: Active Duty, Active Duty Dependent, Non Active Duty Dependent (Retiree) and those over 65 (Medicare Eligible). The matrix in Table 4 allowed a visual conception of the outcome of this analysis. To obtain this actuarial data, an internal survey of patient records was performed to determine frequency of visits. Specifically, a year of chronological notations by FP, IM and Peds providers on Standard Form (SF) 600 were counted. The survey consisted of a sampling of records from patients in the above

beneficiary categories. A process was developed using a Microsoft Exceltm spreadsheet by which random lists were generated for each category. (See Data Collection Section)

TABLE 4, Visits Per Year

<i>Clinic</i>	<i>AD</i>	<i>ADD</i>	<i>NADD</i>	<i>>65</i>
<i>FP</i>	? visits/yr	? visits/yr	? visits/yr	? visits/yr
<i>IM</i>	N/A	? visits/yr	? visits/yr	? visits/yr
<i>Peds</i>	N/A	? visits/yr	? visits/yr	N/A

The literature review uncovered no similar research at present into techniques for determining this highly significant variable of visits per year. Only one value, assumed to be the mean, has been used, and this number varies depending on the source and ranges from 2 to 7. It was my hypotheses that a significant variation existed between visits per year among the nine patient categories which were the focus of this study, and thus, one should not limit enrollment research to one assumed mean value for this variable.

Therefore:

H_0 : The population means of FP, IM and Ped visits per year were equal.

or: $H_0: \mu_1 = \mu_2 = \mu_3$

H_1 : Not all the population means were equal.

or: $H_1: \mu_1 \neq \mu_2 \neq \mu_3$

The level of significance was chosen at .05, and a one-way analysis of variance was selected for this test using the SPSStm Statistical Software Package. The decision rule was to reject H_0 and accept H_1 if the p value was less than .05.

It was also decided to test variance among visits per year from the four patient categories of care: AD, ADD, NADD and >65:

H_0 : The population means of AD, ADD, NADD and >65 visits per year were equal.

$$\text{or: } H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$$

H_1 : Not all the population means were equal.

$$\text{or: } H_1: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$$

The level of significance was chosen at .05, and an one-way analysis of variance was again selected for this test using SPSS_{tm}. The decision rule was to reject H_0 and accept H_1 if the p value was less than .05. Following the ANOVA tests, Tukey-HSD tests were performed to pinpoint between which groups significant variation occurred.

Supply of Clinic Capacity

Based on information gathered in the Literature Review, a computer simulation was chosen as the analytical tool for this study. The MedModel_{tm} software package was selected due to its quality graphical animation capabilities, its menu-driven user-friendliness, and its ability to simulate the hundreds of simultaneously-occurring events of a primary care setting. Through simulation, this study determined the best estimate of patient visits (throughput) that may occur for FP, IM and Peds during the course of a year. Three separate models were built to represent the three clinics. See Appendices 2a, 2b and 2c. Copies of the three models are included with submission of this Graduate

Management Project, and it is recommended readers review the animated simulations to gain a better understanding of this methodology.

Computations

After obtaining the results from the three diagnostic tools mentioned above, a spreadsheet served to process the data into usable format. The basic formula in Figure 1 converts the above findings into enrollment numbers. For the Family Practice Clinic, the product of Family Practice Active Duty (FP-AD) beneficiary Enrollment (a given because all Active Duty are enrolled in Prime automatically and have first priority) and FP-AD Visits-per-year was subtracted from FP-ADD Throughput and then divided by FP-ADD Visits per year to yield FP-ADD Enrollment capacity.

**FIGURE 1, Enrollment Computation
Family Practice Clinic for ADD Beneficiaries**

$$\text{FP-ADD Enrollment} = [\text{FP-ADD Throughput} - (\text{FP-AD Enrollment} * \text{FP-AD Visits-per-year})] / \text{FP-ADD Visits-per-year}$$

Example:

$$20,565 = [53,158 - (562 * 0.911)] / 2.56$$

After this computation is made, the same formula was used to determine FP-NADD Enrollment. However, the study determined the FP-ADD Demand for Enrollment was greater than FP-ADD Enrollment Capacity. Thus, the MTF was not capable of enrolling any FP-NADD beneficiaries. Once Enrollment capacity for each Clinic was

determined, it was divided by the number of providers per clinic to yield the size of each PCM's panel.

Computer Simulation Model Description

Subjects and Objects of Study

Entities. Three categories of entities were studied in this project which modeled the FP, IM, and Peds Clinics. An entity for the purpose of this study is defined as anything that is processed through a system. Entities may have user-assigned attributes and characteristics which travel with the entity throughout the system (Harrell et al 1995). The major entity in the Primary Care model is the *patient*. The *patient*, depending on the model, was characterized as: a family practice patient, an internal medicine patient, or a pediatric patient. A second type of entity is the *phone call*, which takes the provider away from treating scheduled patients. The provider also receives several "hallway consults" throughout the day, unscheduled patients that show up in the provider's office seeking services. Such consults are grouped with phone calls received and are accounted for with the *phone call* entity. The third category of entity comprised the events which took the physician out of the work force and included official leave or pass (*leave*), deployments (*deploy*), training (*train*), on-call duty (*on call*), on-call recovery (*MOD*), medical procedures (*proc*), Troop Medical Clinic duty (*TMC*), administrative time (*admin*), and committees (*comm*).

Resources. Resources are defined as a person or item used to perform an operation or activity (PROMODEL 1996). In this model, there are three types of resources. The first

type of resource is the physician, and depending on the number of physicians in a given clinic, is assigned a name of *Doc1*, *Doc2*, *Doc3*, etc. The second category of resources is the physician extender, and includes the names *Ext1*, *Ext2*, *Ext3*, etc., again depending on how many are actually assigned. The third resource type is the para-provider and is called *LPN*. This category includes Licensed Practical Nurses (LPNs), which are both military and civilian, and Certified Nursing Assistants (CNA) which include civilians and Army Medical Specialists (91Bs). These three categories of resources remained constant for all three clinic models.

The Patient Flow Process

The patient flow process in the simulation involved routing entities (patients) through a series of locations where care was administered by resources (providers and para-providers). The patient entered the model at the clinic entrance and proceeded to a multi-channel, single server queue. When a desk clerk was free, the patient checked in and completed necessary paperwork. The patient then sat in the waiting room until called by a para-provider who took the patient to the screening room. In the screening room, vital signs were taken, and the patient was taken to one of the provider's two exam rooms. If the two rooms were both full, the patient was taken to an auxiliary waiting room until an exam room was empty. Patients waited for providers in exam rooms. When the providers arrived, they treated the patients, and the patients were released. The provider then entered patient data into the CHCS System, completed the patient chart and completed the Ambulatory Data System patient data sheet while the patient exited the model through the clinic main waiting room.

Processes Impacting on the Provider

Several processes diminished the amount of time providers were available each day for patient appointments to include phone calls, meetings, leave, and duty assignments outside the clinic. The phone call process involved the routing of the phone call entities, *FPphone*, *IMphone* and *PEDphone*, into providers' offices. In the animated simulation, phones were represented graphically by blue dots on providers' desks. An incoming call caused the dot to turn green, and forced the provider to spend time away from patients. When the phone call was completed, this entity exited the model. The routing path of the phone call, unlike the path of patients, was invisible to the simulation observer.

The meeting process forced providers and para-providers to attend meetings in the break room. This was simulated by assigning down times to the resources and by assigning applicable resources to the break room for each meeting. Meetings included Continuous Quality Improvement, Officer Professional Development, and Perinatology that met for varying times once per month. Providers' exam rooms were also assigned down times corresponding to resource meeting downtimes in order to close them during the meetings. Several additional entities were developed to facilitate other processes that took physicians away from patient appointments. The rate at which providers were removed from the Clinic and the duration of their absence represented the mean number of providers actually lost to such processes per day and the mean time necessary to accommodate the activity. The *On_call* entities pulled physicians, not extenders, away from appointments in order to perform Medical Officer of the Day duty. Each Clinic requires one physician to be "on-call" at all times. The *FPOD*, *IMOD* and *PedOD* entities

removed physicians from the Clinics for the duration of a day in order to recover from the previous day's "on-call" duty. Another entity, *Leave*, allowed providers to take annual leave and removed them from their Clinics for a day. *Deploy* was established as an entity for the purpose of taking providers away from patients to deploy on training missions with combat troops or to go out-of-town for other temporary duty assignments such as Continuing Medical Education. Another entity called *Train* called providers away to conduct required in-town training such as Advanced Trauma Life Support or Hand Gun Qualification Training. The *Proc* entity was implemented to take providers out of circulation in order to perform procedures such as Vasectomies and Coposcopies. *Admin_Time* was another entity which modeled the absence of providers due to authorized administrative time. *TMC* was the name of the entity which pulled providers to the Troop Medical Clinic in order to assist with sick-call. Finally, the entity *Comm* took physicians out of the Clinic to attend various committee meetings. Each of the three models used a slightly different mix of entities and resource/location downtimes to simulate a realistic loss of providers for each clinic.

Data Collection

Demand for Enrollment

Data was collected from several sources in order to answer this question of estimated demand. First, the MEPRS Workload Trend Analysis Report for FY 96 was used to obtain the number of visits to the FP, IM, and Peds Clinics. Second, necessary data was found in the DIMS database on the number of beneficiaries in the EACH catchment area. This data was provided for the categories of ADD, NADD and over 65.

The number of patients in the AD category, seen exclusively at EACH, came from two sources: The EACH Outpatient Records Section identified the Military Units for which Medical Records were stored, and a phone interview with the leadership of each Unit yielded the total numbers of AD patients assigned. The last source of data was the ADS from which 37,594 records of patients were generated for every visitor to the Clinics under study including patient name, beneficiary category, and Clinic name (See next section for more details on this ADS research). These data records were surveyed in order to determine the percentage of specific Clinic visits made by AD, ADD, NADD and >65 patients.

Visits Per Year

An important portion of the project was now required: determination of the number of visits per year for each category of patient to the Family Practice (FP), Internal Medicine (IM), and Pediatric (Ped) Clinics. The ADS was capable of producing reports consisting of patient names and social security numbers for beneficiary categories of patients who visited the Family Practice, Internal Medicine and Pediatric Clinics beginning in February 1996 when the System came on line. Once this data was consolidated in the form of a spreadsheet, social security numbers were randomly selected for each category of patient. These ID numbers were used to pull a random selection of patient medical records from the Outpatient Records Room.

This presented a challenge because no reports currently existed that listed patient names by the four categories [active duty (AD), active duty dependent (ADD), non-active duty dependent (NADD), and Medicare Eligible(≥ 65)] and by one of the three clinics.

Names and Social Security Numbers were required to pull medical record from the shelf. Nine categories of names were required for this survey (FP-AD, FP-ADD, FP-NADD, FP- ≥ 65 , IM-ADD, IM-NADD, IM- ≥ 65 , Ped-ADD, and Ped-NADD). From this list of names, a "pull list" of randomly selected names and Social Security Numbers from each category were needed for submission to the Outpatient Records Section.

A process was developed using a Microsoft Exceltm spreadsheet by which random lists were generated for each category. First, the Ambulatory Data System (ADS) data base, which contained information on all visiting patients, was queried for the names, Social Security Numbers, CHCS Patient Category Codes (PATCATS), and ages of those seen in FP, IM and Peds. Second, this query was downloaded into three separate spreadsheets (FP, IM and Peds); each contained thousands of data lines. Each line represented a patient visit: FP with 23,878 lines, IM with 8,662 and Peds with 5,054. Third, the lists were purged of duplicate names. This could not be accomplished by standard "highlighting and deleting" due to the magnitude of the lists. Therefore a macro program was written within the spreadsheets which evaluated each line to see if it was a duplicate of the line above it, in which case the line was deleted. The program ran automatically until the lists were scrubbed. Fourth, the lists were segmented by patient category. Because there is no CHCS PATCAT which represents the ≥ 65 category, the first step in the segmentation process was to sort by age. This compiled the ≥ 65 list from which to pull patient records. Next, since the PATCATS all contained an A, N, F, M, or C service identification as their first character, these prefixes were stripped in order to reduce the number of sorts required. This was performed using the Spreadsheet's Replace command. The under-65 categories were then sorted by PATCAT using another

macro program which insured the ≥ 65 category was not included. Fifth, a pick-list of 100 randomly-generated names was established for each patient category. To complete this task, each name was assigned a random number in a newly created column using the spreadsheet's RAND function. Each category of patient was then sorted by random numbers, and the resulting top 100 names were copied to pick-lists. Again, the size of the spreadsheets required a macro program to generate the random numbers and re-sort the lists.

After the pull lists were generated, the patient records were surveyed to determine how many visits occurred during the period from October 1, 1995 through October 31, 1996. This information was extracted by reviewing SF 600s for visits to one of the three clinics. Data was then transferred into the sample size spreadsheet to determine the appropriate sample size in addition to the mean annual visits for each category.

Supply of Clinic Capacity

Several entity/staff interactions were examined, and data collected, in order to construct a valid simulation model. Patient interaction times were required to obtain a distribution of times spent in the waiting room with the desk clerk, in the screening room with the para-provider, and in the exam room with the provider. Distribution type and parameters such as mean and standard deviation were written into the simulation processing logic code. Front desk times were taken from personal observation, while screening room times and exam room times were taken from a questionnaire known as the Clinic Patient Episode Monitoring Tool (See Appendix 3). Staff and providers were briefed on the use of this tool prior to implementation, and the approach involved desk

clerks recording check-in time, para-providers recording time-in and time-out of patient screening, and providers recording time-in and time-out of patient exam-room episodes.

Data on provider phone calls was collected from the hospital's Composite Health Care System (CHCS) into which providers' record phone consults and hallway consults were recorded. Hallway consults are coded as phone consults in CHCS. This data indicated the frequency of calls, and personal interviews with providers determined the mean time for such episodes of care.

Information was also generated on events that took providers away from patients. Data on deployments was found in the previous years' monthly Situational Reports generated by the Health Education and Readiness Division of the MTF. Deployments are unique to Military Medicine and force providers away from home on soldier-support missions to such areas as Kuwait, the Mojave Desert of California, and fire-fighting expeditions. Medical Officer of the Day duty, expected of physicians in all three clinics, allowed them to take compensatory time off. Data on the frequency of compensatory time, as well as leave, mandatory training, and conferences was collected from Daily Status Reports for each Clinic which is collected and held by the hospital's Ambulatory Services Department. Information on committee meetings, Troop Medical Clinic taskings and procedures performed was gained from Clinic-published schedules and personal interview with providers. Data on the frequency and duration of staff meetings was obtained from personal interviews with Clinic chiefs and Clinic head nurses.

Two additional data collection activities that added value to the simulation warrant mention. Data was collected from the hospital Facilities Management Section. Architectural drawings were obtained so that the model's background could be designed

to scale and resemble the actual Primary Care Clinics at EACH. Information was also gathered on the arrival patterns of patients. This information can be collected from End of Day Processing Reports generated by CHCS and through personal observation.

The patient encounter data from screening times and exam times, after it was confirmed to pass the sample size test, was loaded into a software program called Stat::Fit_{tm}. This program is designed to match analytical distributions to user data using three goodness of fit tests: Chi-squared, Kolmogorov Smirnov, and Anderson Darling. The program applied the three tests in an effort to fit the inputted imperial data to 21 popular distributions. The hypotheses established were as follows:

H_0 : The distributions are the same

or: $H_0: O = E$

H_1 : A significant difference exists between the distributions

or: $H_1: O \neq E$

The .05 significance level was selected, and the results of the Chi-Square tests are reproduced below. The Null hypothesis was rejected if the calculated value was greater than the critical value. In three circumstances (IM-Screening, Ped-Screening and Ped-Exam) the three tests rejected the imperial data as fitting any of the 21 distributions. However, the program identified the distributions which most closely fit the data.

FP-Screen Distribution: Triangular, $\chi^2 = 1.39$, $\chi^2_{\text{crit}} = 7.81$, Fail to Reject

IM-Screen Distribution: Beta, $\chi^2 = 37.3$, $\chi^2_{\text{crit}} = 11.1$, Reject

Ped-Screen Distribution: Exponential, $\chi^2 = 77.2$, $\chi^2_{\text{crit}} = 12.6$, Reject

FP-Exam Distribution: Beta, $\chi^2 = 2.91$, $\chi^2_{\text{crit}} = 9.49$, Fail to Reject

IM-Exam Distribution: Gamma, $\chi^2 = 5.77$, $\chi^2_{\text{crit}} = 11.1$, Fail to Reject

Ped-Exam Distribution: Pearson 5, $\chi^2 = 28.9$, $\chi^2_{\text{crit}} = 12.6$, Reject

Once appropriate distributions were assigned to the encounter times, the times were used in the operations logic of the EACH Primary Care Simulation models built with MedModel_{tm} Simulation Software. Graphs of the fitted distributions for screening episodes appear in Appendices 4a, 4b and 4c. Graphs of the fitted distributions for exam episodes appear in Appendices 5a, 5b and 5c.

Validity, Reliability and Verification

Validity is the extent to which a test measures what it is supposed to measure. Reliability refers to the accuracy and precision of a measurement procedure, that is, the degree to which it supplies consistent results (Cooper and Emory 1995). According to Dr. Lucien Keller, the developer of MedModel_{tm}, there are two superior methods for testing the validity of a computer simulation model. The first method is the Empirical Validation Interview in which the model builder allows the human subjects who appear in the model to view it in the animation mode and validate the type, quantity and time involved in performing each of their tasks. This method validates that the model is a reflection of the process modeled. The second best validity check is the Comparison of

Means technique in which one compares empirical data with computer-generated data of an event which was not the focus of the study. For example, in the Primary Care Simulation, the total time a patient spends in the clinic was not a parameter loaded into the program. Instead, it was an outcome dependent upon all the other data inputs such as reception time, screening time, and exam time. Thus, the mean of empirical data collected on patients' total time in the clinic can be compared to the mean of the simulated patients' total time in clinic to determine if a statistical difference exists (Keller 1997).

Both recommended validation procedures were performed on the Primary Care Model. First, the model was transported by laptop computer to the offices of providers who were simulated in the study. The providers were asked, "How well does this model simulate your actual daily activities?" The model was altered based on feedback from providers until it was validated. The graphic animation capabilities of the software helped the stakeholders validate the processes.

The second step was to compare the computer generated data with the empirical data collected on patients' total time in clinic to determine what statistical differences, if any, existed. The following process was used to validate each of the three models. A variable *ClinTime* was established to record the total time of each patient's visit. *ClinTime* was determined by subtracting the clock time each patient exited the clinic from the clock time the patient entered the clinic. The computer model generated the mean and standard deviation of *ClinTime* based on patient encounters during the twelve months of operation. Empirical data was collected through use of the Patient Episode Monitoring Tool and through personal observation for which the mean and standard

deviation was determined for a random sample of patient episodes $N \geq 30$. The following hypothesis was established:

H_0 : There is no significant difference between the mean of the empirical total patient time in clinic and the mean of the Primary Care Model total patient time in clinic.

$$\text{or: } H_0: \mu_1 = \mu_2$$

H_1 : A significant difference exists between the mean of the empirical total patient time in clinic and the mean of the Primary Care Model total patient time in clinic.

$$\text{or: } H_1: \mu_1 \neq \mu_2$$

A level of significance of .05 was selected. Because only an answer to the question of equality vs. inequality was sought, and because the sample sizes were large, the two-tailed z test for independent populations was used. The decision rule was as follows: Fail to reject H_0 if Test Ratio < 1.96 or Test Ratio > -1.96 . Otherwise, accept H_1 . Table 5 (below) lists the results of the validation studies which demonstrate the model was valid. The ultimate test of validity will come after the recommendations of the study are implemented, and real life operations at EACH produce similar results to what the model predicted.

TABLE 5, Z Test Statistics

<i>Clinic</i>	<i>Mean</i>		<i>Standard Deviation</i>		<i>Sample Size</i>		<i>Test Ratio</i>
	<u>Empirical</u>	<u>Model</u>	<u>Empirical</u>	<u>Model</u>	<u>Empirical</u>	<u>Model</u>	
<i>FP</i>	43.5	47.6	11.7	20.4	30	53,760	-1.92
<i>IM</i>	52.6	56.2	15.1	28.9	42	16,870	-1.54
<i>Peds</i>	45.8	50.6	15.7	24.0	40	7,901	-1.95

Results of Validation:

Family Practice Clinic:	Fail to reject H_0
Internal Medicine Clinic:	Fail to reject H_0
Pediatric Clinic:	Fail to reject H_0

Reliability, the ability of the Primary Care Model to deliver consistent results, was tested by comparing the results of the model run for months 1 through 12 with months 13 through 24. A comparison of the total throughput for each clinic yielded no significant differences between runs 1 - 12 and 13 - 24 in terms of total output or *ClinTime*.

Verification is making sure the model works the way the modeler intended it to work. Verification may be confirmed by running the simulation while closely monitoring its events through observing the animation and by observing counters depicting variables' values (Harrell et al 1995). This was conducted by the researcher, who went to great lengths to build the three models in likeness to the EACH Primary Care setting. Special consideration was given to insure operating hours, FTEs, treatment times, and building architecture resembled true life. Insuring patients left the model at the close of business hours, that is, no patients were left "sleeping" in the clinic overnight, was an additional verification of the model's accuracy.

Sample Size

Throughout this project, data was collected from samples. This included samples of patient records and patient encounters. Appropriate sample sizes were determined by the following formula:

$$n = \frac{s^2}{\delta_x^2} + 1$$

key: n = the size of the sample
s = the standard deviation of the sample
 δ_x = the standard error of the mean (interval estimate desired/z score of confidence interval desired) (Cooper and Emory 1995)

A confidence interval of 95% was selected, and an error of estimate was chosen based on each individual situation.

TABLE 6, Sample Size Calculation

<i>Sample</i>	<i>Std Dev</i>	<i>Interval Est</i>	<i>Conf Interv</i>	<i>Samp Size</i>
<i>FP Screen Time (Min)</i>	1.85	0.66	95%	30
<i>FP Exam Time (Min)</i>	6.10	2.00	95%	36
<i>IM Screen Time (Min)</i>	2.52	0.50	95%	98
<i>IM Exam Time (Min)</i>	7.74	1.50	95%	102
<i>Ped Screen Time (Min)</i>	2.94	0.66	95%	77
<i>Ped Exam Time (Min)</i>	7.87	1.66	95%	86
<i>Reception Time (Sec)</i>	29.00	8.00	95%	51
<i>FP-AD Visits (Records)</i>	1.35	0.35	95%	58
<i>FP-ADD Visits (Records)</i>	1.70	0.50	95%	45
<i>FP-NADD Visits (Records)</i>	1.48	0.50	95%	34
<i>FP->65 Visits (Records)</i>	2.09	0.50	95%	67
<i>IM-ADD Visits (Records)</i>	2.56	0.50	95%	101
<i>IM-NADD Visits (Records)</i>	2.00	0.50	95%	62
<i>IM-.65 Visits (Records)</i>	2.13	0.50	95%	70
<i>Ped-ADD Visits (Records)</i>	1.47	0.50	95%	34
<i>Ped-NADD Visits (Records)</i>	2.19	0.50	95%	74

A system to evaluate appropriate sample size was developed using a Microsoft Exceltm spreadsheet. The above formula for sample size was input into the cells, whereby standard deviation, confidence interval and interval estimate were input to yield a sample size. This method of calculation was used in determining the sample size for three time

distributions: the time a patient is serviced at the reception desk, the time a patient spends undergoing screening, and the time a patient spends with a provider in an exam room.

Additionally, sample sizes for patient record reviews were computed.

THE RESULTS

The results of the study are now provided in four sections which culminate in the answer to the research question. First, the demand for MTF TRICARE Prime enrollment within the MTF catchment area is listed. Second, a forecast of the number of visits each beneficiary would make to the MTF over the next year is presented. Supplied third is next year's forecasted throughput per clinic. Finally, the enrollment estimates per beneficiary category are provided. The study found that the optimal panel sizes for Family Practice, Internal Medicine and Pediatric PCMs are 1,335 patients, 617 patients, and 632 patients respectively.

Demand for Health Care

The estimate of demand shows the numbers of beneficiaries, by category, who would desire enrollment in specific clinics. This compilation was an important component in the equation because, broken down by category of patient, it helped to prioritize the limited enrollment capacity.

TABLE 7, Estimated Demand for Care (patients desiring enrollment*)

<u>Clinic:</u>	<u>Category of Patient</u>			
	<u>AD</u>	<u>ADD</u>	<u>NADD</u>	<u>>65</u>
Family Practice	562	25,935	8,412	1,066
Internal Medicine		1,144	14,128	5,274
Pediatrics		5,482	1,755	

* Assumes all those who are eligible to enroll will enroll

Annual Beneficiary Visits

The second key piece to the equation was a determination of how many times beneficiaries seek care in the MTF. This table demonstrates the wide variation between clinics and categories of beneficiary.

TABLE 8, Estimated Visits Per Year Per Beneficiary

<u>Clinic:</u>	<u>Category of Patient</u>			
	<u>AD</u>	<u>ADD</u>	<u>NADD</u>	<u>>65</u>
Family Practice	0.91	2.56	2.59	3.01
Internal Medicine		4.53	3.45	4.11
Pediatrics		2.50	2.36	

Table 9 depicts the results of the one-way analysis of variance to determine the variation between means of visits per clinic. Thus, H_0 was rejected ($P = .0000$) at the 5 percent level of significance. The multiple range Tukey-HSD test, at significance level .05, specified significant variation between IM Clinic visits and FP Clinic visits and between IM Clinic visits and Ped Clinic visits.

TABLE 9, Analysis of Variance: FP, IM and Ped Visits

<i>Source</i>	<i>D.F.</i>	<i>SS</i>	<i>MS</i>	<i>F Ratio</i>	<i>F Prob</i>
<i>Between</i>	2	224.4541	112.2270	28.2749	.0000
<i>Within</i>	387	1536.0590	3.9691		
<i>Total</i>	389	1760.5131			

Table 10 depicts the results of the 2nd ANOVA. Thus, H_0 was rejected ($P = .0000$) at the 5 percent level of significance. The multiple range Tukey-HSD test, at

significance level .05, specified significant variation between AD visits and ADD visits, between AD visits and NADD visits, and between AD visits and >65 visits. The two tests prove significant variance exists between the 9 categories of patients' visits per year to the Primary Care Managers of EACH.

TABLE 10, Analysis of Variance: AD, ADD, NADD and 65 Visits

<i>Source</i>	<i>D.F.</i>	<i>SS</i>	<i>MS</i>	<i>F Ratio</i>	<i>F Prob</i>
<i>Between</i>	3	252.4329	84.1443	21.5371	.0000
<i>Within</i>	386	1508.0802	3.9069		
<i>Total</i>	389	1760.5131			

Clinic Throughput

Table 11 reports the results of the computer simulation study which estimated throughput over the next year for each clinic. The simulation provided the supply of visits and was the final element required to determine empanelment numbers.

TABLE 11, Estimated Throughput Derived From Computer Simulation

<u>Clinic:</u>	<u>Total Annual Supply of Clinic Visits Available</u>
Family Practice	53,760
Internal Medicine	16,870
Pediatrics	7,901

Recommended Enrollment

The following table depicts the number of beneficiaries, by category, that each clinic may enroll. One may note that no enrollment capacity is allocated to NADD or over

65 categories. This is because shortfalls exist in Family Practice and Pediatrics when comparing Table 7, estimated demand, with Table 11, estimated supply. Leadership must choose between the best allocation method for distributing 11,687 IM appointments. These appointments could supply 4,565 Family Practice enrollees, that is, persons desiring to enroll with a Family Practice PCM, but for whom no supply was available, would be enrolled with an IM PCM instead. Likewise, these appointments could serve to make up for a combination of both Pediatric Clinic and Family Practice undercapacity.

TABLE 12, Estimated Supply of Care (capacity for enrollment)

<u>Clinic:</u>	<u>Category of Patient</u>			
	<u>AD</u>	<u>ADD</u>	<u>NADD</u>	<u>>65</u>
Family Practice	562	20,800		
Internal Medicine*		1,144		
Pediatrics		3,160		

* 11,687 appointments are left over in IM with which to divide between the Family Practice and Pediatrics Clinics to cover supply shortfalls

Assuming leadership chooses to enroll the Family Practice beneficiaries who are left over with an IM PCM, empanelment numbers would look like this:

TABLE 13, Panel Size

<u>Clinic:</u>	<u>Total</u> <u>Enrollees</u>	<u>Number of</u> <u>Providers</u>	<u>Panel</u> <u>Size</u>
Family Practice	21,362	16	1,335
Internal Medicine	5,709	9.25	617
Pediatrics	3,160	5	632

DISCUSSION

As demonstrated in the results, there were three secondary research questions which were key to answering the primary question: Enrollment Demand, Visits Per Year, and Primary Care Throughput. Demand for enrollment was calculated using DMIS data which subdivided Evans Hospital catchment area beneficiaries into the four categories. One potential weakness of this project is the assumption that all beneficiaries who are eligible to enroll in MTF Prime will in fact desire to do so. Every TRICARE market is different, and demand for MTF Prime enrollment reflects the general level of past satisfaction and TRICARE marketing within a given market. The leadership at Evans Hospital expect demand for enrollment to remain high, due to an aggressive promotional campaign and the results of informal surveys.

The results of health care demand analysis were important because it was assumed there would be more demand for care than supply of care. However, no previous study had estimated how much demand for clinic utilization by category of beneficiary existed in the community. It was Congressionally mandated through Title 10 of the U.S. Code that first priority for TRICARE enrollment goes to active duty soldiers. Dependents of active duty receive the next priority. Retirees receive the lowest priority (Joseph 1996). This study supplied the tool to estimate how much care was demanded in each category so that priority could be assigned proportionately to an appropriate clinic.

In determining user visits per year, a medical record review was conducted, and episodes of care were tallied for each clinic and beneficiary category. The Army records episodic primary care in a chronological hand-written format on a form known as an SF 600. These forms were reviewed in each patient's outpatient medical record. In the event that a patient received care at more than one clinic during the year (i.e. visited both the FP and IM clinics), the clinic with the most visits was considered the dominant clinic of choice, and the minority visits were not counted with the statistics for that clinic. Also excluded from any compilation was data in a chart showing an equal number of visits to two clinics.

The potential weakness with this analysis is assuming each patient will continue to visit the clinics in the same frequency after the TRICARE health insurance plan is implemented. It is possible, due to increased access standards, that visits-per-year will increase when beneficiaries learn it is easier to gain access to the appointment clerk and to the appointment calendar. An analysis was conducted to estimate increased demand using the RAND Health Insurance Study's estimates of elasticity. According to the study, for every 10% reduction in waiting time, there is a corresponding 1.2% increase in demand (Feldstein 1993). Applying this model to the Each Hospital situation, one could assume a 6.24% increase in demand with the start of TRICARE. This is determined in Figure 2; by assuming a 52% decrease in waiting time (30,584 new beneficiary population/63,760 old beneficiary population). However, the TRICARE Managed Care Support Contract spells

FIGURE 2, Estimation of Increased Demand

$$\text{Increased Demand} = \frac{\{[1 - (30,584/63,760)]/100\} * 1.2}{10}$$

out the requirement of the contractor to provide a 24-hour nurse advice line to the Each Hospital beneficiaries. This will reduce the demand for care because it is a service not previously provided and because it will eliminate many unnecessary trips to the primary care clinics. It is assumed the demand reduction of the nurse advice line will counter-act the demand increase caused by the increase in access, and thus the RAND model was not applied.

The MedModel_{tm} simulation yielded the final data required to solve the research problem. No doubt the most time-consuming portion of the study, this representation of the EACH Primary Care Clinic displayed estimated throughput over the course of the next 12 months. The only shortfall to computer simulation is the output is only as good as the data that is input. In this case, much information was obtained through survey of physicians. It is possible, although unlikely, the physicians could attempt to “game” the model by inflating their times with patients, on the phone, or attending meetings when completing the survey instrument or in personal interview with me. The motivation behind such efforts would be an attempt to reduce their workload.

CONCLUSION AND RECOMMENDATIONS

The Primary Care Simulation model yielded valuable information to leadership at Evans Army Community Hospital as they addressed empanelment problems. The hospital will also benefit significantly from the market analysis research used in the study and from the capability to increase Enrollment Based Capitation allocations through the process reengineering which the simulation supports. At the time this writing, enrollment is ongoing. Recommendations of this study were incorporated into the empanelment plan.

The study reveals the capacity in which each clinic may accommodate enrollees, but in addition, allows leadership some options. These options are a result of the 11,687 available appointments in the Internal Medicine Clinic. These appointments, in the past, were filled with NADD and over 65 categories of patient. With priorities going to AD and ADD categories, by law, and with unfulfilled demand left over in both Family Practice and Pediatrics, a system of reallocation is required. Leadership could opt to invest all this available Internal Medicine appointment time in Family Practice visits by ADDs because there is an estimated shortfall of 5,135 ADD patients who will seek to enroll with a Family Practice PCM but who will be turned away due to limited capacity. Therefore, 4,565 patients would enroll with an Internal Medicine PCM.

Likewise, these available Internal Medicine appointments could be used to fill the 2,322-patient estimated shortfall in Pediatrics and while allowing 2,298 patients turned away from Family Practice to enroll in Internal Medicine. Another option, which is

avored at present by the organization's leadership is to reserve 2,000 positions for NADDs to enroll with Internal Medicine PCMs. This option, while politically sound, may prevent all ADDs who desire enrollment to enroll with the MTF. If this option is implemented, 4,793 appointments will be left in Internal Medicine to distribute between Family Practice and Internal Medicine enrollees. This could equate to 1,872 Family Practice enrollees or 1,917 Pediatrics enrollees, neither of which covers the projected shortfalls.

It is also recommended that the organization continue to use and support Computer Simulation analysis, the key to this research project. The literature review has demonstrated simulation has many health care applications, especially in "what if" scenario analysis. At the time of this writing, MedModeltm training is scheduled for twelve staff members, and there is interest in three new research projects: Primary Care pari-provider staffing decisions, and Primary Care exam room configurations, and Obstetrical/Gynecological Clinic process reengineering. Future analytical decision-makers will use the model built during this Graduate Management Project (GMP) to evaluate many process improvements involving the Primary Care Clinics.

With the resource allocation method known as **Enrollment Based Capitation (EBC)**, there is great potential for the use of computer simulations to model DoD primary care clinics. Resource Based Capitation is scheduled to start in Fiscal Year 1998 and involves an annual prepayment to MTFs for each enrollee. Capitation is a powerful tool which realigns incentives and the focus of care away from high-cost settings and treatment to community-based settings better able to prevent the incidence and prevalence of disease and injury. The strategic goals of the MTF will include increasing TRICARE MTF Prime

enrollment through increased productivity. Commanders will look for ways to increase MTF primary care throughput, and thus TRICARE Prime enrollment, in order to increase revenues. The model established by this GMP will serve ideally to evaluate the effects of bringing in new providers either by hiring them outright or procuring them through resource sharing or resource support agreements with MCS contractors.

Enrollment Based Capitation also forces MTF commanders to develop strategic marketing plans to deal with competitive forces in the healthcare marketplace. For the first time, DoD faces competition from the MCS contractor networks, and commanders will soon learn their success depends on increasing primary care capacity/enrollment, reducing costs per episode of care, and satisfying patient needs so that MTF enrollees remain enrolled at the MTF. Strategic goals and decisions must be customer-focused and driven by market forces. This project, in addition to determining empanelment numbers and serving as an executive decision support system, takes the first step toward developing a **marketing plan** by analyzing the EACH primary care target markets. The results of a detailed look at market segments are outlined in Table 7 (Estimated Demand for Care) and Table 8 (Estimated Visits per Year per Beneficiary). Nine market segments were analyzed in terms of their demand for Primary Care at EACH, and, through ANOVA testing, significant variation was found to exist between the groups. After using the Primary Care Simulation to increase enrollment capacity at EACH, it is recommended leadership market this new-found capacity to the market segment that will yield the most profit for the hospital. According to this research, the NADD segment desiring enrollment with a Family Practice Clinic PCM consists of 8412 beneficiaries who visit the FP Clinic an average of 2.59 times per year. This group is more profitable than the NADD segment

desiring enrollment with an Internal Medicine Clinic PCM which consists of 14,128 beneficiaries who visit the IM Clinic an average of 3.45 times per year.

The Primary Care Simulation project was a comprehensive study comprising a Primary Care System and its complex processes. The findings provided information to executive decision-makers in three important areas: PCM empanelment, future "what if" analysis to support Enrollment Based Capitation, and market segmentation analysis. Simulation offered a more substantive approach than other attempts at determining empanelment numbers. The Primary Care Clinics are complex sets of interactive processes with each process impacting on another. Simulation allows one to view the clinic as a system, as opposed to a linear equation using mean calculations and approximations as variables. The enrollment of beneficiaries into TRICARE Prime started on April 1, 1997, and the findings of this study were used to set enrollment rates at the MTF.

APPENDIX 1

Alphabetical List of Key Acronyms Included in this Paper

>65	Over-65 (Medicare eligible) category of patient
AD	Active duty service member beneficiary category of patient
ADD	Active duty dependent beneficiary category of patient
ClinTime	A Variable: the total amount of time a patient spends in a clinic
EACH	Evans Army Community Hospital
FP	Family Practice Clinic at Evans Army Community Hospital
FP->65	Medicare eligible that would prefer to enroll with a FP PCM
FP-AD	Active duty beneficiary that would prefer to enroll with a FP PCM
FP-ADD	ADD beneficiary that would prefer to enroll with a FP PCM
FP-NADD	NADD beneficiary that would prefer to enroll with a FP PCM
IM	Internal Medicine Clinic at Evans Army Community Hospital
IM->65	Medicare eligible that would prefer to enroll with an IM PCM
IM-ADD	ADD beneficiary that would prefer to enroll with an IM PCM
IM-NADD	NADD beneficiary that would prefer to enroll with an IM PCM
NADD	Non-Active duty dependent (retiree) beneficiary category of patient
PATCAT	A field in the CHCS PAD Module designating category of patient
PCM	Primary Care Manager
Ped	Pediatric Clinic at Evans Army Community Hospital
Ped-ADD	ADD beneficiary that would prefer to enroll with a Ped PCM
Ped-NADD	NADD beneficiary that would prefer to enroll with a Ped PCM
Throughput model.	The number of patients that have both entered and exited the

List of Computer Simulation Entities

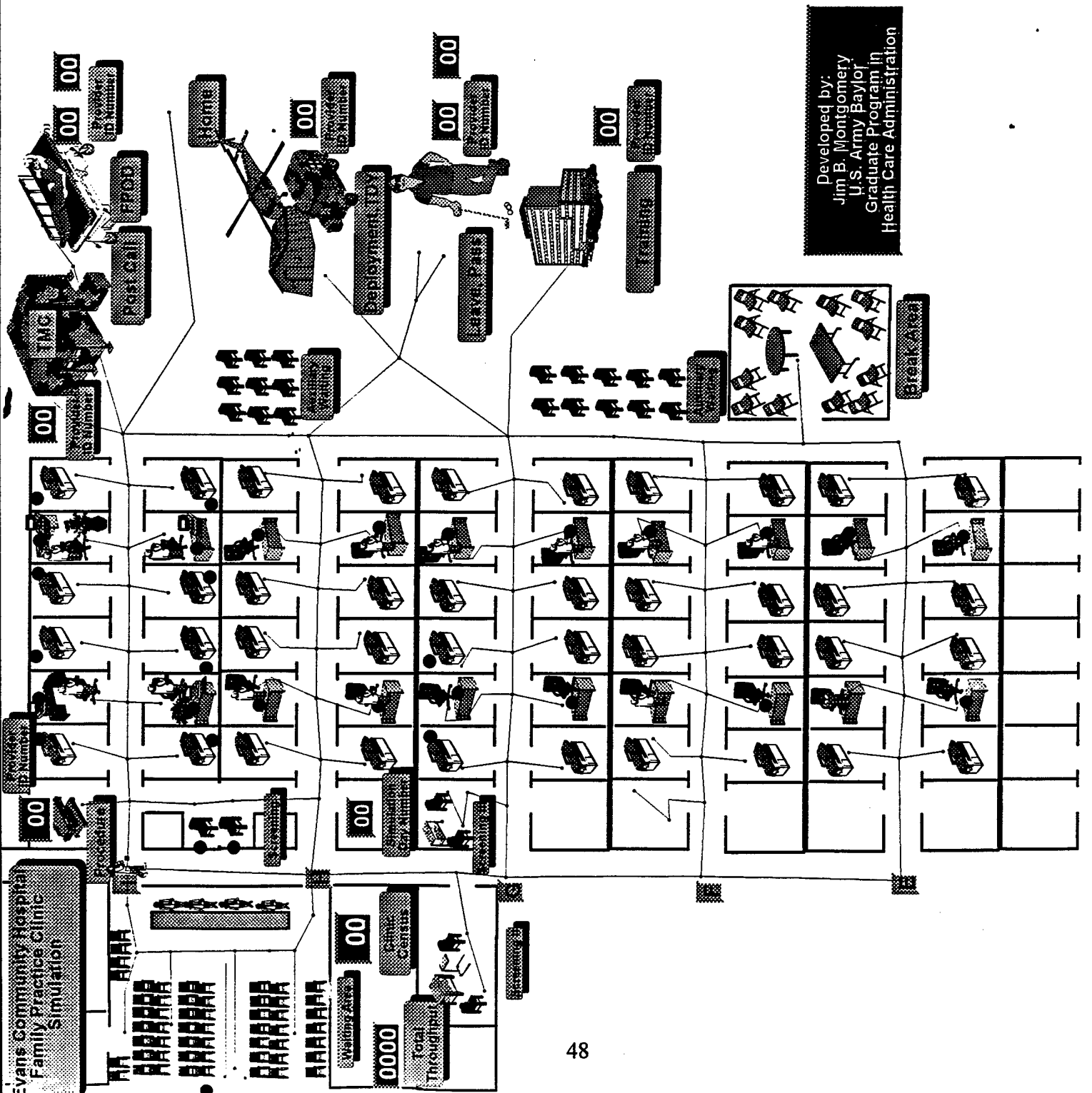
Admin	Forces a provider to take time away for administrative duties
Comm	Forces a provider to prepare for and serve on committees
Deploy	Forces a provider to take time away for external training
Leave	Forces a provider to take leave
MOD	Forces a provider to take time away for MOD next-day recovery
On call	Forces a provider to take time away for MOD duty
Patient	Simulates a patient routed through the clinic from entrance to exit
Phone call	Simulates a phone call routed to providers' offices.
Proc	Forces a provider to take time away for performing procedures
TMC	Forces a provider to take time away for Troop Medical Clinic duty
Train	Forces a provider to take time away for internal training

List of Computer Simulation Resources

Doc1, Doc2, Doc3...	Physicians serving either FP, IM or Ped Clinics
Ext1, Ext2, Ext3...	Physician extenders serving either FP, IM or Ped Clinics
LPN	Term for para-provider....can include LPN, CNA or 91B

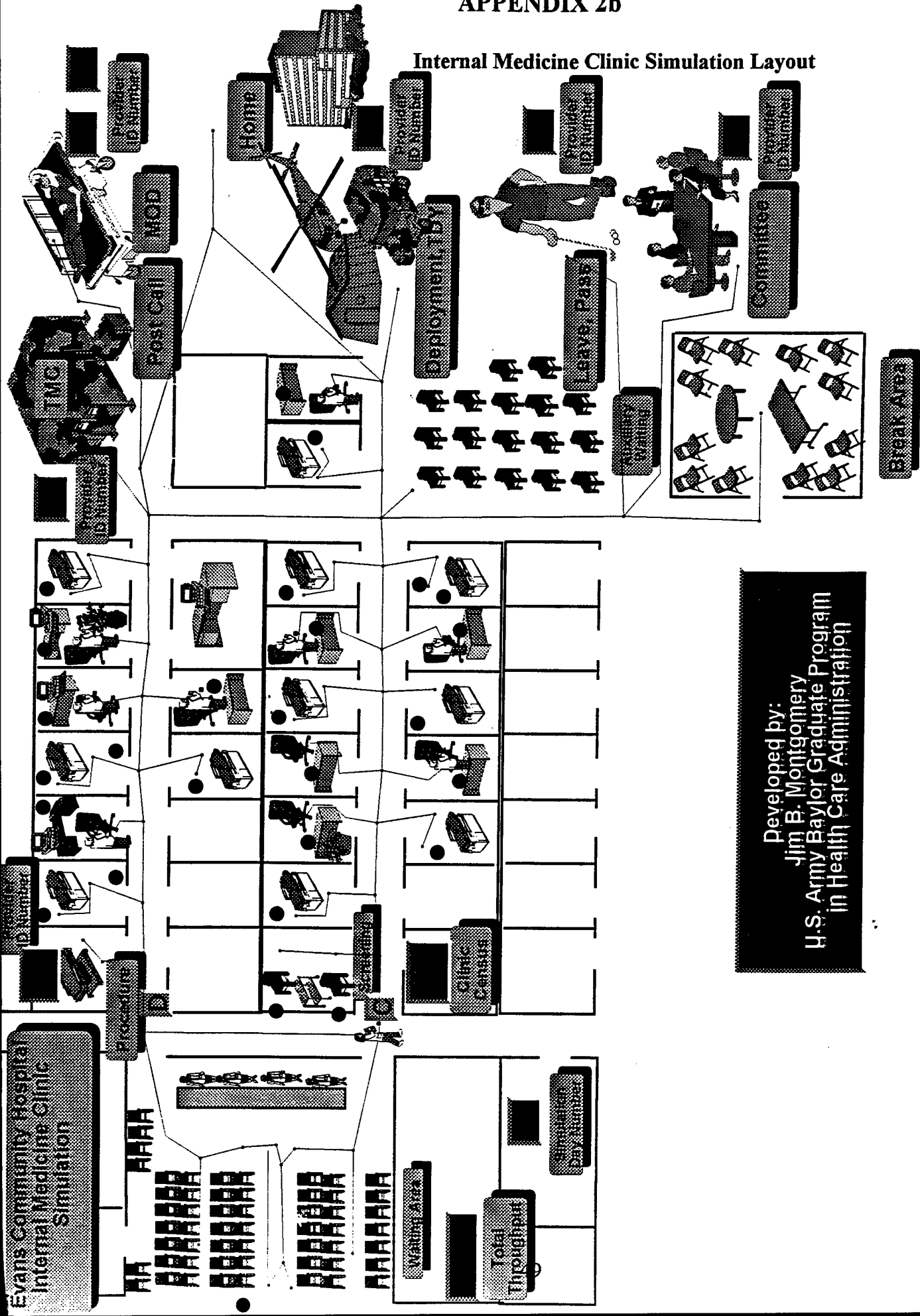
APPENDIX 2a

Family Practice Clinic Simulation Layout



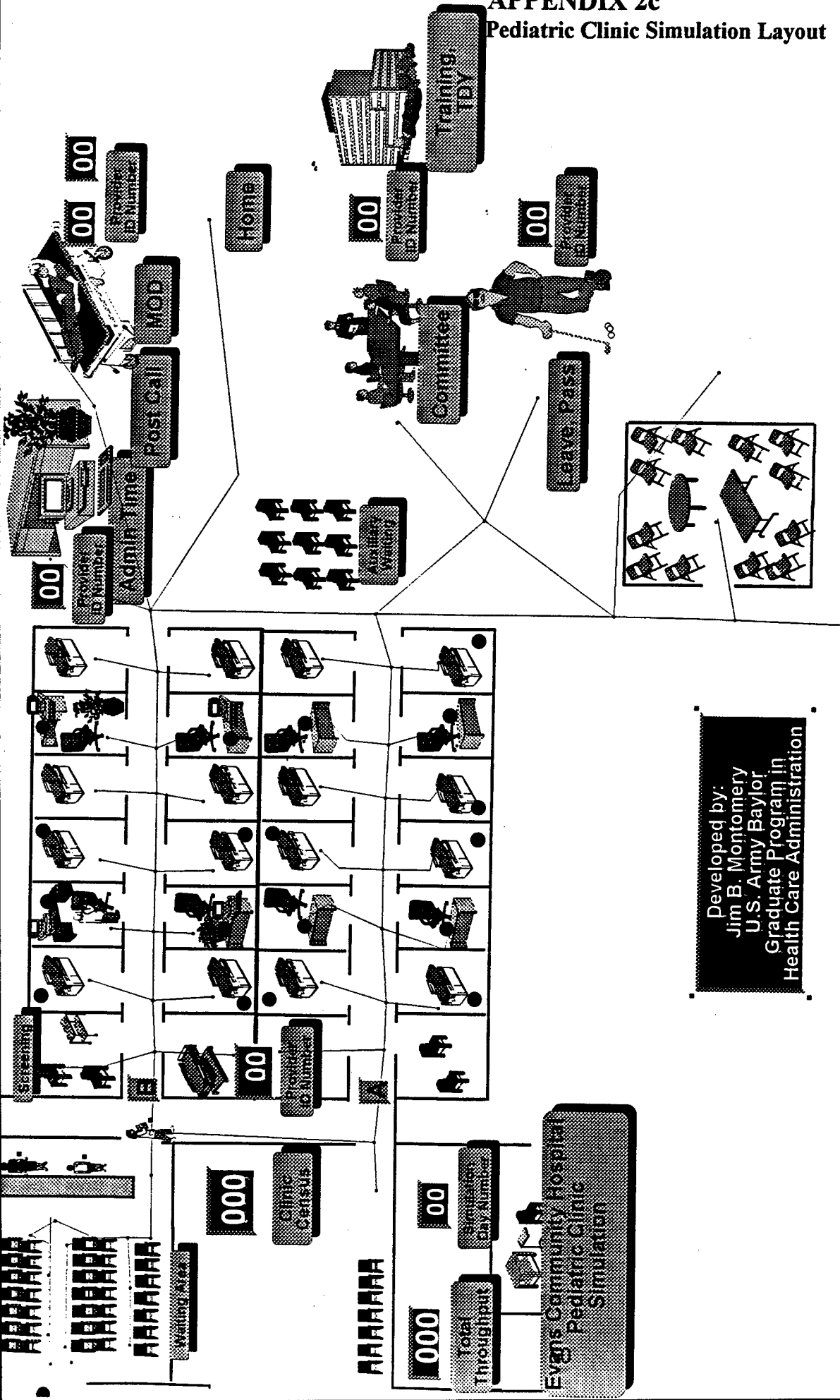
APPENDIX 2b

Internal Medicine Clinic Simulation Layout



Developed by:
Jim B. Montgomery
U.S. Army Baylor Graduate Program
in Health Care Administration

APPENDIX 2c Pediatric Clinic Simulation Layout



Developed by:
Jim B. Montgomery
U.S. Army Baylor
Graduate Program in
Health Care Administration

APPENDIX 3

Clinic Patient Episode Monitoring Tool

INTERNAL MEDICINE CLINIC
PATIENT EPISODE MONITORING TOOL

DATE 03 FEB 1997

CHECK IN 0845
APPOINTMENT TIME 0900

SCREENING STARTED 0950
SCREENING COMPLETED 0954
(INCLUDES SCREENING CARRIED OVER
INTO EXAM ROOM)

PROVIDER ENTERS EXAM ROOM 0858

(IF APPLICABLE)
PATIENT SENT TO ANCILLARY
SERVICE Lab

PATIENT RETURNS FROM
ANCILLARY SERVICE
(SAME DAY ONLY) _____

PROVIDER EXITS EXAM ROOM 0915

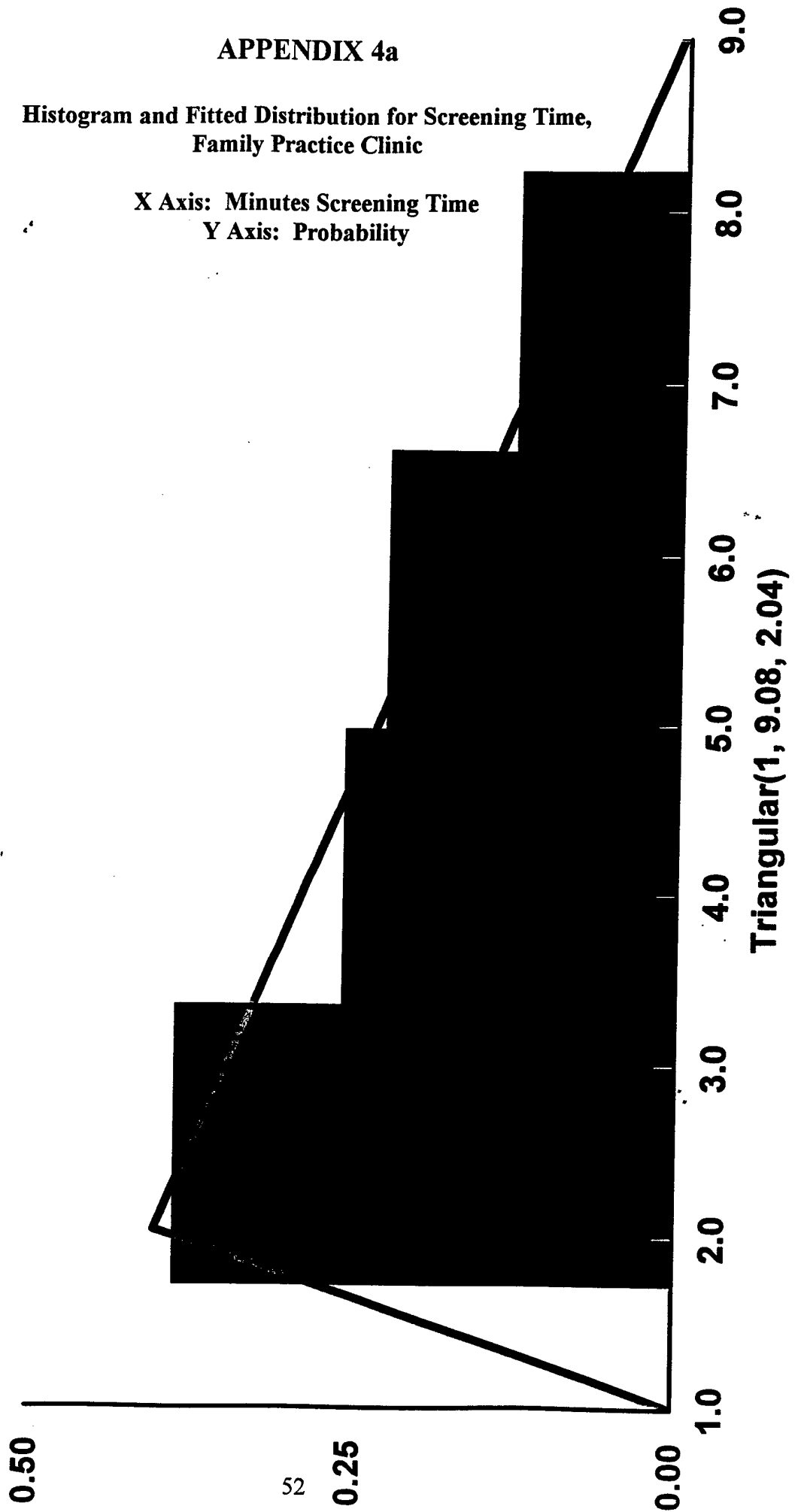
PROVIDER COMPLETES NOTES/
CHCS ENTRY 0920

NOTE: PLEASE ENTER TIMES ROUNDED
TO CLOSEST MINUTE.

PLEASE STAMP WITH PATIENT CARD
BELOW.

30 ~~4~~ ~~8~~ ~~8~~ OPR 1211
~~20~~ ~~20~~ ~~20~~ ~~20~~
20 AUG 91 F AD USA
18 ~~18~~ HSI ~~18~~ ~~18~~
18TH CORPS SPT ON DP 6-6798

Fitted Distribution

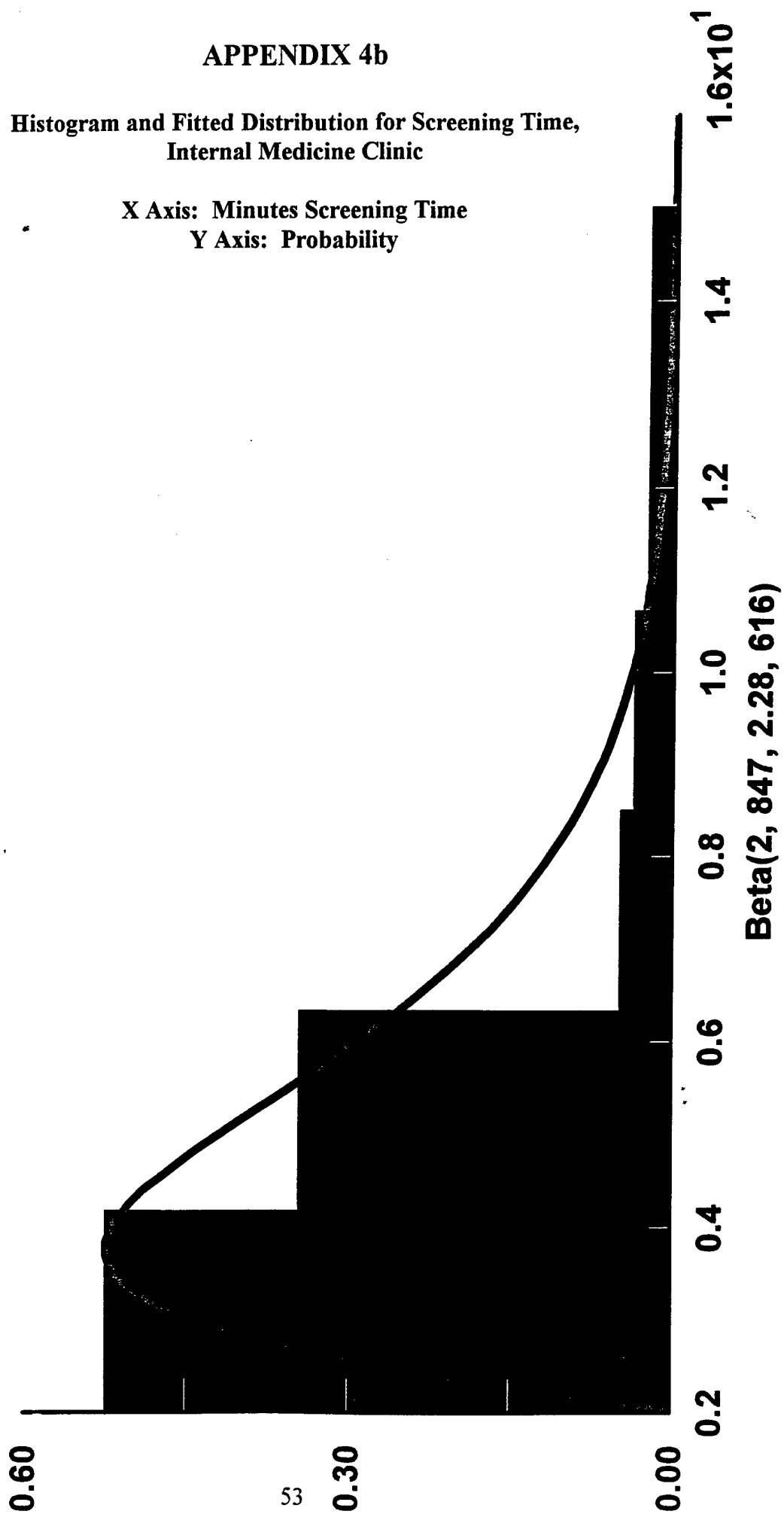


APPENDIX 4b

Histogram and Fitted Distribution for Screening Time,
Internal Medicine Clinic

X Axis: Minutes Screening Time
Y Axis: Probability

Fitted Distribution

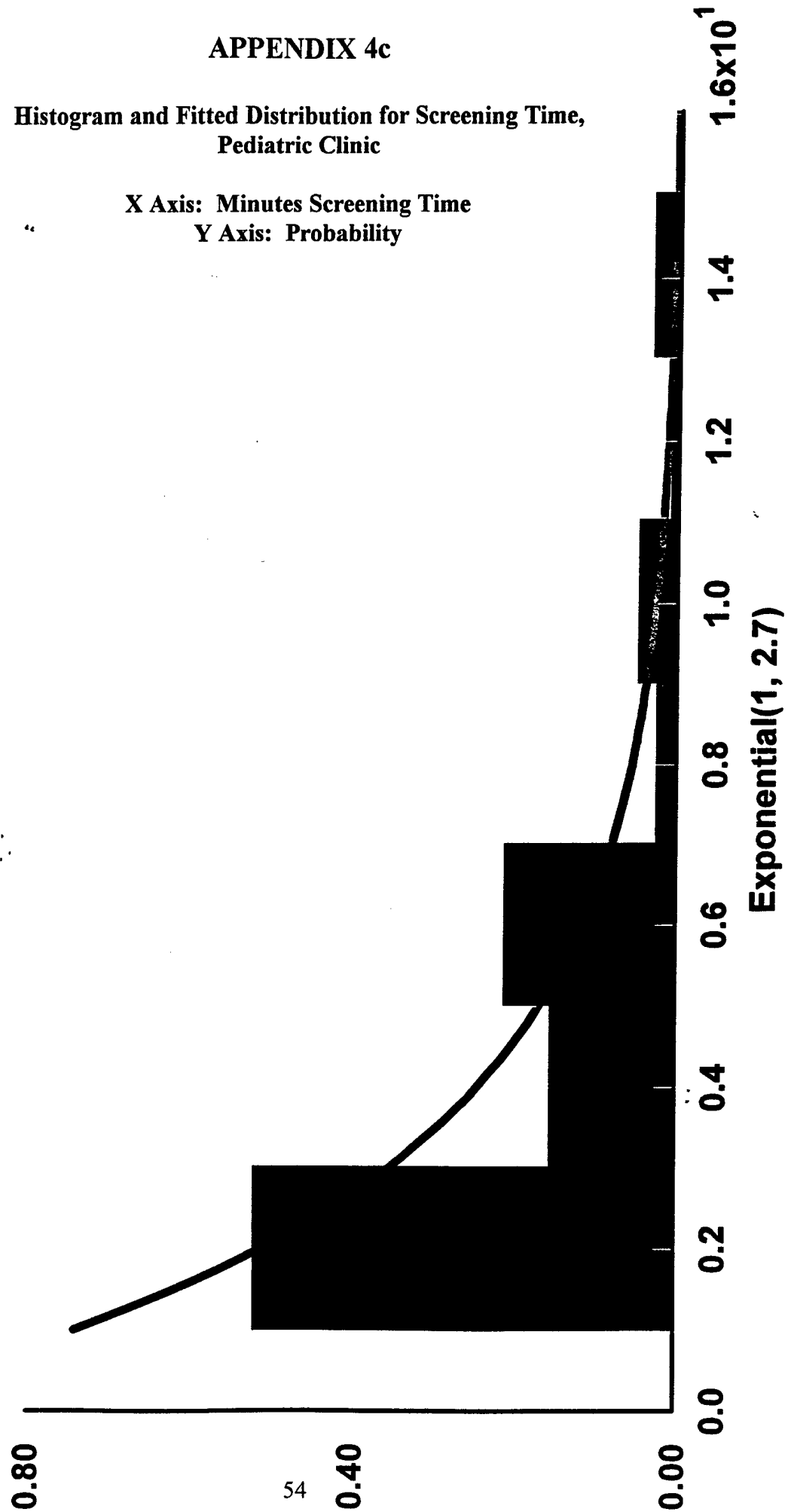


APPENDIX 4c

Histogram and Fitted Distribution for Screening Time, Pediatric Clinic

X Axis: Minutes Screening Time
Y Axis: Probability

Fitted Distribution

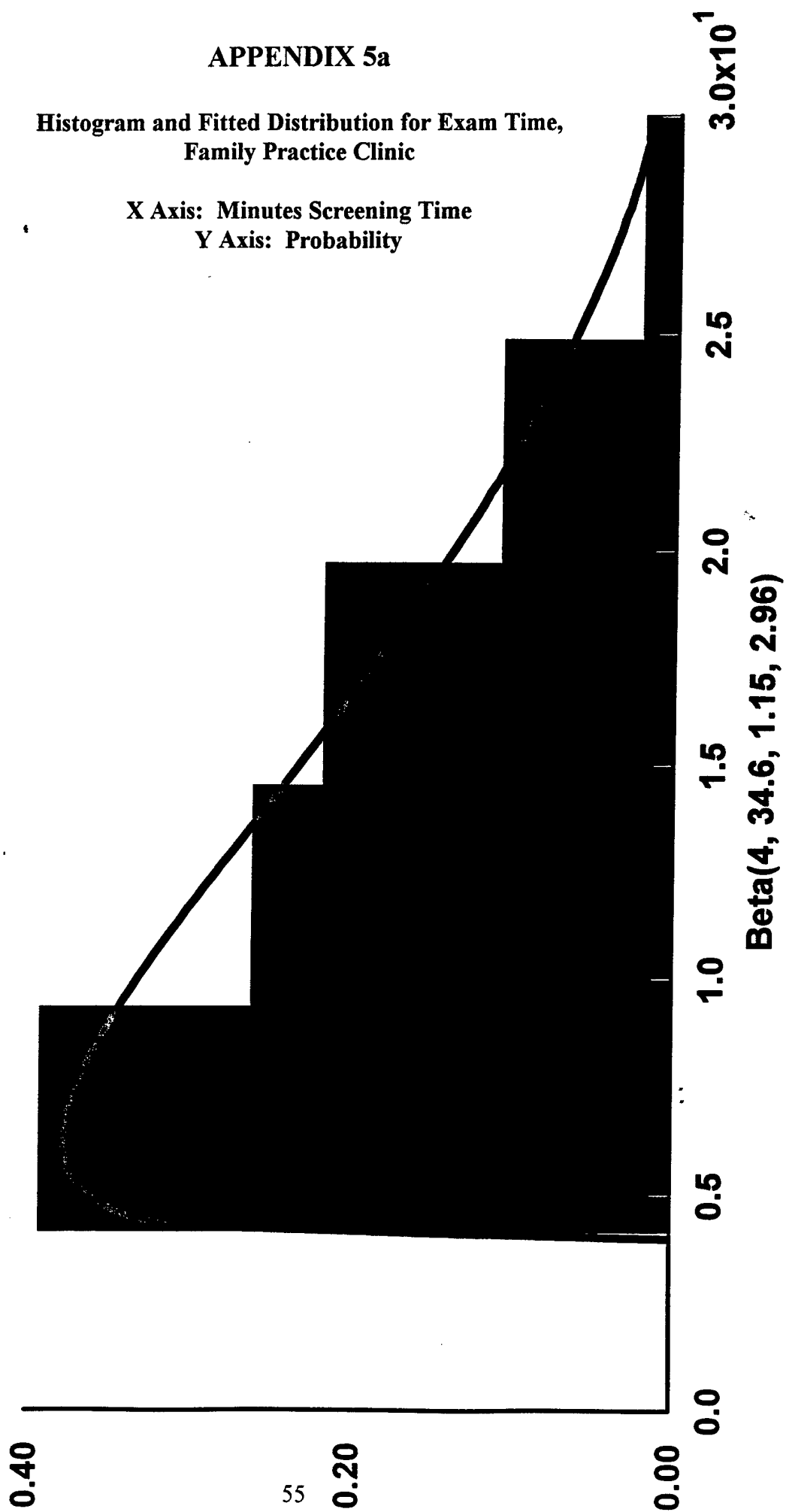


APPENDIX 5a

Histogram and Fitted Distribution for Exam Time,
Family Practice Clinic

X Axis: Minutes Screening Time
Y Axis: Probability

Fitted Distribution



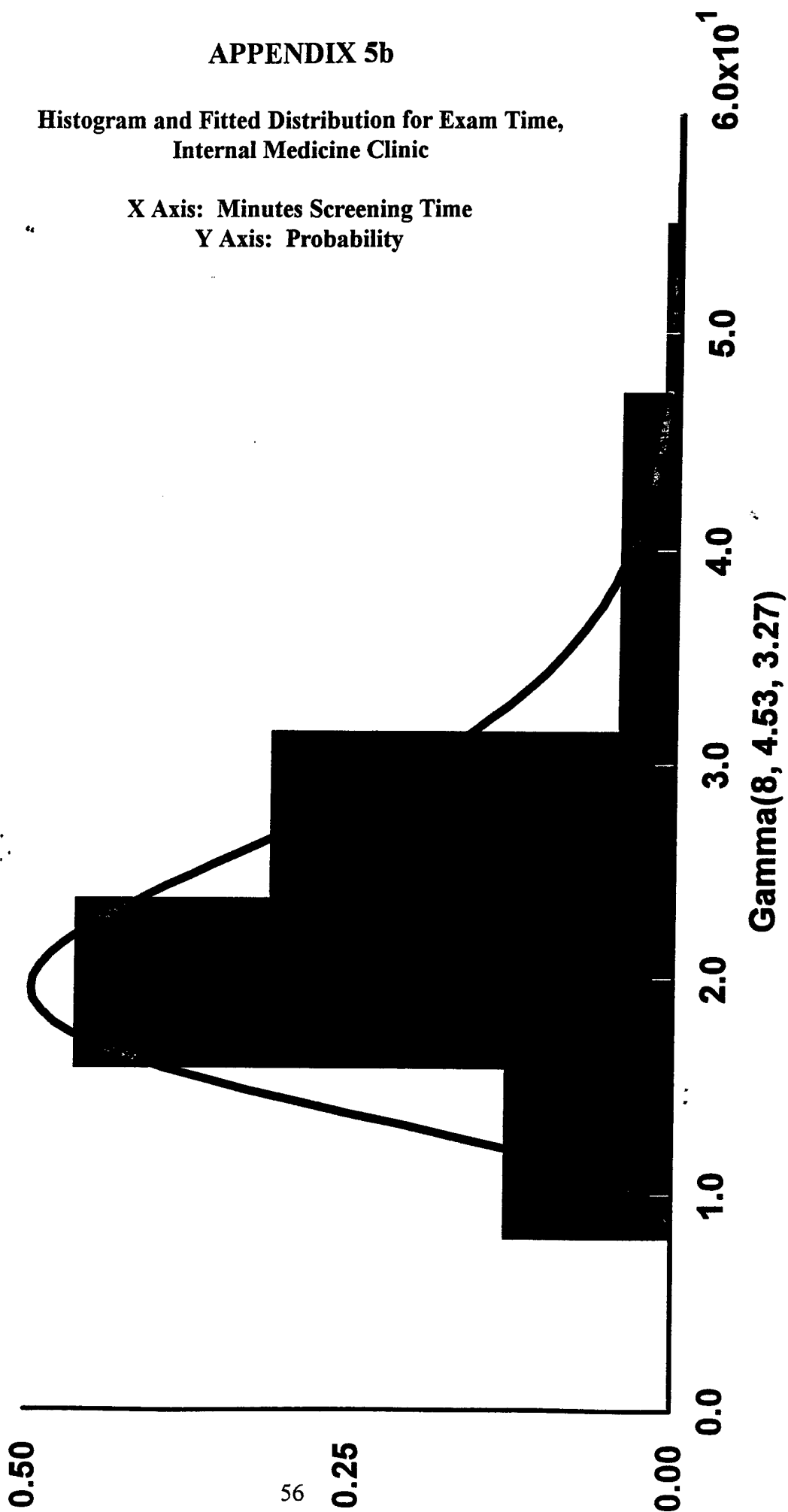
APPENDIX 5b

Histogram and Fitted Distribution for Exam Time,
Internal Medicine Clinic

X Axis: Minutes Screening Time

Y Axis: Probability

Fitted Distribution

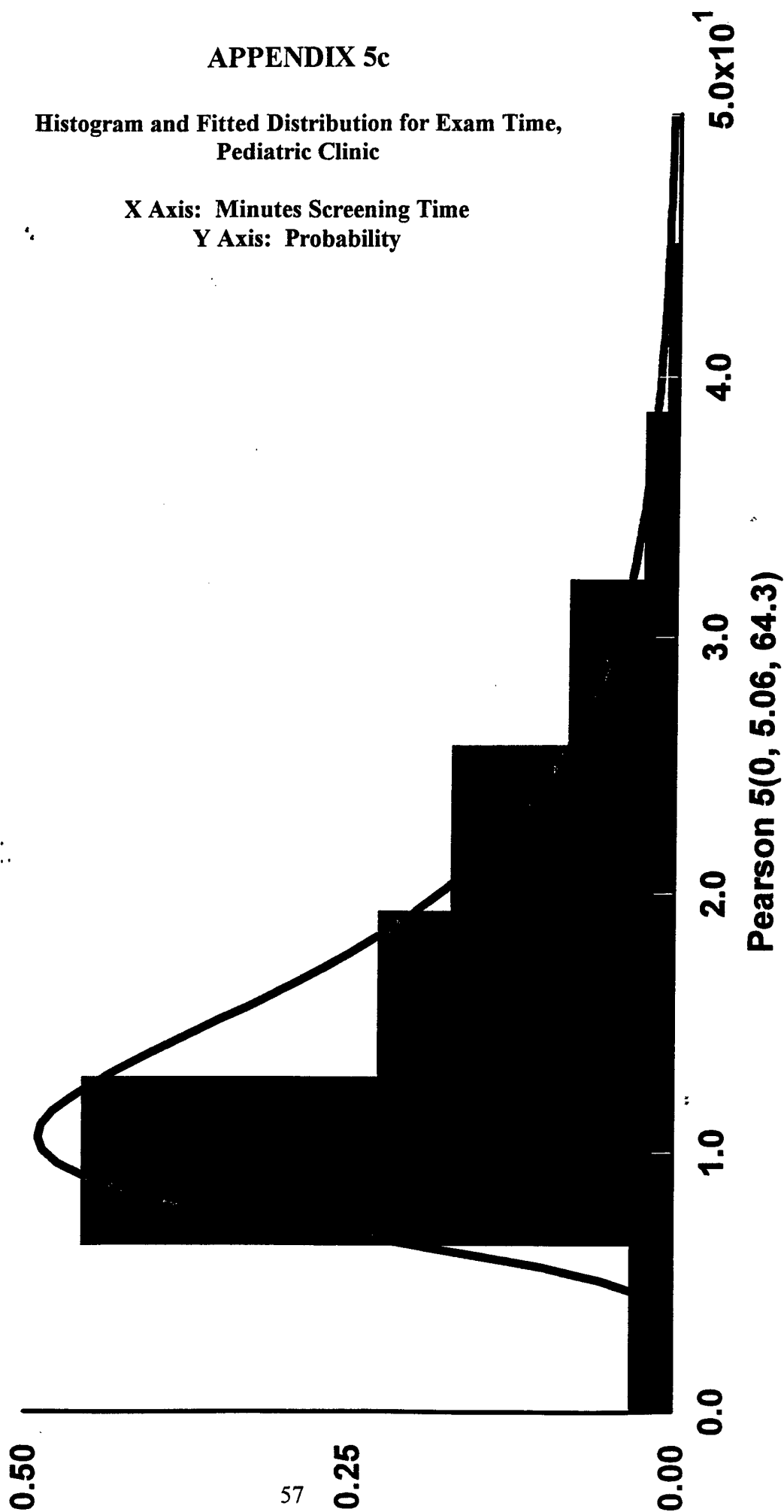


APPENDIX 5c

Histogram and Fitted Distribution for Exam Time, Pediatric Clinic

X Axis: Minutes Screening Time
Y Axis: Probability

Fitted Distribution



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